DESCRIPTION

STEERING COLUMN APPARATUS

Field of the Invention

The present invention relates to a steering column apparatus for constituting a steering device for a vehicle or the like, and more specifically, to a technology for securing a sufficient space around the knees of a driver even when a tilt adjusting mechanism or a power steering apparatus of a column assist type, or the like, is additionally provided in the steering column apparatus.

Related Background Art

Since a steering apparatus of a vehicle is to be used (for steering) by a wide range of drivers, it is preferable that the position of a steering wheel is adjustable in compliance with the physique or the posture of each driver. In order to satisfy such preference, a tilt adjusting mechanism or a telescopic adjusting mechanism is widely employed not only for passenger cars, but also for commercial vehicles.

The tilt adjusting mechanism is a mechanism to adjust the position of a steering wheel in the up-

and-down direction, and is constituted by a tilt pivot for rockably supporting a steering column, a tilt position fixing means for fixing the steering column at a desired position (rocking angle), and other elements. On the other hand, the telescopic adjusting mechanism is a mechanism for adjusting the position of the steering wheel in the back-and-forth direction (the axial direction of the steering shaft), and is constituted by an expandable unit of a double tube type or the like to be used for expansion and/or contraction of the steering shaft, a telescopic fixing means for fixing the steering shaft at a desired position (with an amount of expansion/contraction), and other elements.

Hitherto, it is general that, as the tilt fixing means, a distance bracket formed of a steel plate is connected to a steering column formed of a steel pipe by welding, and this distance bracket is pressed to be fixed by a vehicle body-side bracket which is formed of a steel plate. However, with such an arrangement, the number of the constituent parts and that of the welding steps are increased, and moreover, various inconveniences are inevitably caused by thermal distortion, etc., at the welding. As a result, a structure has been proposed in Japanese Patent Application Laid-Open No. 8-276852 or the like (hereinafter called the prior art) in which a

distance unit is formed to be expanded by plastic working.

Fig. 8 is a side view of an essential portion of a steering column apparatus of the prior art, and Fig. 9 is an enlarged cross-sectional view taken along line C-C in Fig. 8. The steering column 1 of the prior art is formed of a steel pipe, and a distance unit 21 is formed to be expanded in a lower part in Fig. 8 and Fig. 9. A tilt bolt 23 is inserted through the distance unit 21, and there is provided a tilt adjusting mechanism which is thread-engaged comprised of a nut 25 thread-engaged with the tilt bolt 23 and a tilt lever 31. In this steering column apparatus, the nut 25 advances along the tilt bolt 23 due to thread-engagement therewith upon rotation of the tilt lever 31, disposed on a side of the bracket 4 on the car body side, so as to clamp and press the distance unit 21 (steering column 1) by and between the tilt brackets 3, 4 and/or to release this clamped state. According to the steering column apparatus of the prior art, it is possible to reduce the number of the constituent parts and that of the welding steps to reduce the manufacturing cost, and at the same time, to prevent inconveniences which may be caused by the thermal distortion or the like at the welding.

For a steering system of a vehicle, there is also widely employed a so-called power steering

apparatus which uses an external power source to perform steering assist. Hitherto, as a power source for a power steering apparatus, an oil pressure pump of a vein type is generally used, and such an oil pressure pump is mostly driven by an engine. However, a power steering apparatus of this type exerts a substantial drag on an engine since the oil pressure pump is usually driven all the time (around several to ten horsepower at the time of the maximum load). As a result, it is difficult to employ such power steering apparatus in a mini vehicle or the like of small engine displacement, and fuel efficiency is inevitably deteriorated significantly even in a vehicle of comparatively large engine displacement.

Accordingly, in order to solve these problems, an electric power steering apparatus (hereinafter called EPS) employing an electric motor as its power source has recently attracted attention. The EPS has such characteristics as that no direct drag on an engine is generated since a built-in battery is used as the power source for the electric motor, that deterioration of the fuel efficiency (a load on the engine related to an alternator) can be avoided since the electric motor is actuated only for steering assist, that an electronic control can be effected very easily, etc. Note that EPSs are classified into a column-assist type and a rack-assist type,

depending on a position of attachment of the electric motor or a decelerating mechanism (hereinafter called the EPS mechanism). Currently, a column-assist type EPS which is advantageous in terms of the manufacturing cost and a space of installation is dominantly used. In a column-assist type EPS, the EPS mechanism is secured to the tip end of the steering column to be integral therewith, and, in a steering column apparatus provided with a tilt adjusting mechanism, the EPS mechanism is rocked together with the steering column around the tilt pivot at a tilt adjustment.

However, the above-described steering column apparatus of the prior art has the following drawbacks. That is, in the steering column of the prior art, the tilt bolt 23 is positioned below the steering shaft 13 so that an amount of protrusion thereof is small, compared with that in a steering column to which a distance bracket is connected by welding. However, it is inevitable that the lower ends of the tilt brackets 3, 4 are greatly protruded from the lower surface of the steering column 1 in a state that the steering column 1 is most elevated. For this reason, when the driver moves forward due to inertia at the time of collision of a vehicle, there is a possibility that the driver's knee will strike the lower end edges of the tilt brackets 3, 4 formed

of steel plates.

On the other hand, in the steering apparatus provided with a column-assist type EPS, a comparatively large EPS mechanism is secured to the tip end of a steering column to be integral therewith, so that an adjacent space in the passenger compartment is significantly cramped. Particularly, in a small-sized car or the like in which a column-assist type EPS is usually employed, the arrangement of the tilt adjusting mechanism below the steering column becomes an obstacle to securing a sufficient space around the knees of the driver or a survival space at the time of collision.

DISCLOSURE OF THE INVENTION

The present invention has been contrived taking the above circumstances into consideration, and an object thereof is to provide a steering column apparatus which can secure a sufficient space around the knees of a driver even when a steering position adjusting mechanism or a column-assist type electric power steering apparatus is additionally provided.

According to the present invention, there is provided a steering column apparatus comprising: a steering shaft to which a steering wheel is mounted at the rear end portion thereof; a cylindrical steering column for rotatably supporting the steering

column therein; body-side brackets used to sandwich and fix the steering column; a distance unit formed to be expanded from the steering column by plastic working to be sandwiched by the body-side brackets; and position adjusting means for making the position of the steering column with respect to the body-side brackets adjustable within a predetermined adjustment range, wherein the position adjusting means comprises an adjusting bolt for passing through the body-side bracket and the distance unit so as to clamp the distance unit through the body-side bracket, and the adjusting bolt is positioned above the steering shaft.

Also, in the steering column apparatus according to the present invention, it is preferable that the steering column is adjustable in a tilting direction with respect to the body-side bracket, and that the lower end of the body-side bracket is positioned higher than the lower surface of the steering column.

Also, in the steering column apparatus according to the present invention, it is preferable that an electric assist mechanism for assisting a steering power of the steering wheel is secured to the tip end of the steering column.

Also, in the steering column apparatus according to the present invention, it is preferable that the plastic working is performed by hydroforming.

According to a steering column apparatus of the present invention, it is rendered possible to reduce an expanded amount of the distance unit from the steering column to the minimum by, for example, disposing an adjusting bolt immediately above the steering shaft, so as to make a layout of the steering column apparatus easy. In case of the steering column apparatus having a tilt adjusting mechanism, a range of movement of the adjusting bolt is positioned comparatively high with respect to the steering column, so that the lower end of the body-side bracket is difficult to be protruded from the lower surface of the steering column. As a result, there is a less fear that a knee of the driver will strike the body-side bracket at the time of collision or the like of the car.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a lateral view of a steering column apparatus according to a first embodiment of the present invention;

Figs. 2A and 2B are respectively an enlarged cross-sectional view taken along line A-A in Fig. 1 and an enlarged cross-sectional view taken along line B-B in Fig. 1;

Fig. 3 is a lateral view of the steering column apparatus according to the first embodiment;

Fig. 4 is an enlarged cross-sectional view taken along B-B line in Fig. 3,

Fig. 5 is a lateral view of a steering column apparatus according to a second embodiment of the present invention;

Fig. 6 is a lateral view of a steering column apparatus according to a third embodiment of the present invention;

Figs. 7A and 7B are respectively an enlarged cross-sectional view taken along A-A line in Fig. 6 and an enlarged cross-sectional view taken along line B-B in Fig. 6;

Fig. 8 is a lateral view of the essential portion of a steering column apparatus according to the prior art; and

Fig. 9 is an enlarged cross-sectional view taken along C-C line in Fig. 8.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Description will be made below on an embodiment of a steering column apparatus according to the present invention.

Fig. 1 is a side view of a steering column apparatus according to the first embodiment of the present invention, and Fig. 2A is an enlarged cross-sectional view taken along line A-A in Fig. 1.

The steering column 1 is attached to a body-side

strength member 7 through upper brackets 3, 4 which are formed of steel plates by press-forming to serve as vehicle body-side tilt brackets and a pivot bracket 5 which is formed of a steel plate by press-forming, so as to support an upper steering shaft (hereinafter simply called the steering shaft) 13 to be rotatable through bearings 9, 11. The upper brackets 3, 4 and the pivot bracket 5 are preferably mounted on the vehicle body-side strength member 7 to be detachable at a secondary collision by a known mechanism.

The upper brackets 3, 4 have the width in the length direction of the steering shaft, and are extended symmetrically in a direction perpendicular to an extending direction of the steering shaft, that is, the right-and-left direction in Fig. 2A, and integrally comprise a pair of vehicle body mounting portions 3a, 4a secured to the vehicle body-side strength member by the use of fixing members (not shown) such as bolts.

The brackets 3 and 4 are formed as unitary structures, respectively including front wall portions 3b, 4b which are bent substantially at right angles at the front ends of the body mounting portions 3a, 4a of the upper brackets 3,4 to be extended downward, the body mounting portions 3a, 4a, and a pair of side plate portions 3c, 4c which are

bent substantially at right angles inside the front wall portions 3b, 4b, respectively, to be extended backward (to the right in Fig. 1) and in the up-and-down direction.

A steering wheel (not shown) is attached to a rear end of the steering shaft 13 (the right end in Fig. 1), and a lower steering shaft (now shown) is coupled to a tip end of the steering shaft 13 (the left end in Fig. 1) through a universal joint. The lower steering shaft is connected to a rack and pinion mechanism of a steering mechanism which interlocks with tires. In Fig. 2A,reference numerals 15 and 17 denote tilt adjusting holes formed on the upper brackets 3, 4.

The steering column 1 is formed of a steel pipe by hydroforming to take a substantially cylindrical shape, and the steering column 1 is formed with a distance unit 21 expanded at upper positions, corresponding respectively to side plate portions 3c, 4c of the upper brackets 3,4. The distance unit 21 integrally comprises flat side wall portions 21a, 21b which are clamped by and between the side plate portions 3c, 4c of the upper brackets 3, 4 and a top portion 21c which connects these side wall portions 21a, 21b at the upper ends thereof.

The side plate portions 3c, 4c of the upper bracket 3 are formed with elongated holes 15, 17 for

tilt adjustment which will be described later, and circular holes are formed on the side wall portions 21a, 21b of the distance unit 21 to be corresponding thereto. The distance unit 21 is clamped between the side plate portions 3c and 4c of the upper bracket 3 with a predetermined clamping force by the bolt 23, which is inserted through the elongated holes 15, 17 for tilt adjustment of the side plate portions 3c, 4c and through the through holes of the side wall portions 21a, 21b, and a nut 25. Known cam elements 29, 27, a tilt adjusting lever 31 and a thrust bearing 33 are disposed on the bolt 23 between the head portion 23a of the bolt 23 and the bracket side plate portion 3c, from the side of the side plate portion 3c. The cam element 29 is unable to rotate since a projection 27a extended rightward in Fig. 2A is engaged with the elongated hole 15 of the bracket side plate 3c. The other cam element 27 is in an integral relationship with the tilt adjusting lever 31. When the tilt adjusting lever 31 is manually rotated, the cam element 27 is rotated together with the tilt adjusting lever. As a result, a relative position between the cam elements 27, 29 is changed in the axial direction of the bolt 23, so that a distance between the cam element 27 and the nut 29 is changed to change a distance between the side plate portions 3c and 4c, thereby clamping and fixing the

side wall portions 21a, 21b of the distance unit 21 or releasing this clamped and fixed state.

As an adjusting mechanism for tilt adjustment, a known screw mechanism may be employed, instead of the above-described cam mechanism.

In the present embodiment, the above-described distance unit 21 is formed to be expanded in an upper part above the axial line of the steering shaft 13 on the steering column 1, to be extended along a predetermined length of a column intermediate portion.

In case of the present embodiment, the tilt bolt 23 is inserted through the distance unit 21 (steering column 1) immediately above the steering shaft 13 with a predetermined space t (e.g. 1 mm) therebetween.

In a front part of the vehicle seen from the upper brackets 3, 4, the horizontally extended body mounting portion 5a of the pivot bracket 5, serving as the lower bracket on the body side, is secured to the vehicle body-side strength member 7 by a bolt, or the like. The pivot bracket 5 is provided with a pair of vertical plate portions 5b, 5c which are parallel to each other and are extended downward from the body mounting portion 5a.

A column-side lower bracket 41 which is secured to the steering column 1 in a front part of the vehicle integrally comprises flat plate portions 41b, 41c which are extended in the up-and-down direction

to be corresponding to the vertical plate portions 5b, 5c of the pivot bracket 5 to be respectively brought into pressure contact. Circular holes are respectively formed on the flat plate portions 41b, 41c of the column-side lower bracket, and these circular holes receive a pivot bolt 43, thus enabling the flat plate portions to be clamped by the bolt 43 and a nut 45.

In the present embodiment, the column-side lower bracket 41 is formed separately from the steering column 1, and is fixed to the steering column 1 by welding. However, the column-side lower bracket 41 may be formed by expanding the steering column 1 by hydroforming, or the like, in the same manner as the distance unit 21 described above. A cut-away portion 47 in a substantially U shape is formed on the pivot bracket 5 to be open toward a front part of the vehicle, and the pivot bolt 43 is inserted into the rear end side of this cut-away portion 47. Note that the steering column 1 is arranged to be rockable around the pivot bolt 43, and the driver can adjust a vertical position of the steering wheel within a predetermined range by operating the tilt lever 31.

A mode of an operation of the present embodiment will be described in the following.

When the position of the steering wheel becomes inappropriate because of change of drivers, or the

like, in case of the steering column apparatus of the first embodiment, the driver first rotates the tilt lever 31 clockwise to release the cam engagement between the tilt cams 27, 29. Then, the clamping force exerted on the distance unit 21 of the steering column 1 through the upper brackets 3, 4 is released so that the steering column 1 is allowed to rock in a predetermined amount around pivot bolt 43. With this arrangement, the driver can tilt the steering column 1 so as to adjust the steering wheel to a desired vertical position.

Upon completion of the positional adjustment of the steering wheel, the driver rotates the tilt lever 31 counter-clockwise to bring the tilt cams 27, 29 into engagement. Then, the upper bracket 3 is sandwiched with pressure by and between the tilt cam 29 and the nut 25, and the inner surfaces of the upper brackets 3, 4 are brought into pressure contact with side surfaces of the distance unit 21. As a result, the steering column 1 (that is, the steering wheel) is fixed at a desired position with respect to the upper brackets 3, 4.

On this occasion, since the upper bolt 23 is positioned above the steering shaft 13 in the present embodiment, a range of movement of the upper bolt 23 is positioned comparatively high, with respect to the steering column 1, and the vertical dimension of the

upper brackets 3, 4 is conspicuously small as compared with the prior art. As a result, even when the steering column 1 is disposed at the highest position, as shown in Fig. 3 and Fig. 4 (an enlarged cross-sectional view taken along line B-B in Fig. 3), the lower ends of the upper brackets 3, 4 are not protruded from the lower surface of the steering column 1 and there is no fear that a knee or the like of the driver makes contact with the upper brackets 3, 4 even at the time of collision of the car or the like.

On the other hand, in the present embodiment, since the distance unit 21 is formed by hydroforming and a space t between the tilt bolt 23 and the steering shaft 13 is small, the vertical dimension of the steering column 1 in the distance unit 21 can be reduced. With this arrangement and with the small vertical dimension of the upper brackets 3, 4, the tilt adjusting unit can be made compact, so that a layout of the steering column apparatus becomes very easy.

Fig. 5 is a side view of a steering column apparatus according to the second embodiment of the present invention. In the second embodiment, the present invention is applied to a steering column apparatus which is provided with a column-assist type EPS. However, the principal portion of the invention

in the second embodiment is the same as that of the first embodiment, so that the members having the same functions as those in the first embodiment are given the same reference numerals and symbols and description thereof will be omitted.

In the second embodiment, the front end of a comparatively short-sized steering column 1 is thrust to be secured to an EPS housing 51 (which accommodates a decelerating mechanism, a controller, and the like), to be integral therewith, and an electric motor 53 is mounted on a side of the EPS housing 51. When a rotational torque of the steering shaft 13 is detected by a sensor, the electric motor 53 is driven and controlled by the controller to be rotated, and then a rotating force thereof is transmitted to the steering shaft 13 through the decelerating mechanism to perform power assist.

In the second embodiment, a tilt pivot which is defined by the pivot bracket 5 for tilt adjustment is disposed on the EPS housing in a front part of the vehicle, and at a position higher that the steering axial line. The tilt pivot may be provided toward a rear part of the car, rather than in front of the motor.

In the second embodiment, the steering column 1 is provided with the comparatively large EPS housing 51 and electric motor 53. However, since the tilt

adjusting mechanism is compact, like in the first embodiment, the layout of the second embodiment is very easy, compared with that of a conventional apparatus. For example, though an unrepresented meter cluster, etc., are positioned in an upper part of the rear end of the steering column 1, interference between the meter cluster, etc., and the tilt brackets 3, 4 hardly occurs even if a space around the knees of the driver is sufficiently provided, since the vertical dimension of the tilt brackets 3, 4 is small, which results in higher freedom in designing. Note that the mode of operation and the effect at the time of collision or the like of the car described in the first embodiment are entirely the same as those in the present embodiment, so that description thereof will be omitted.

Fig. 6 is a side view of a steering column apparatus according to the third embodiment of the present invention, Fig. 7A is a cross-sectional view taken along line A-A in Fig. 6, and Fig. 7B is a cross-sectional view taken along line B-B in Fig. 6. A steering column 101 is mounted on a vehicle body-side strength member through upper brackets 103, 104 formed of steel plates by press-forming and a lower bracket 105 formed of an alluminium alloy by die casting, so as to rotatably support an upper steering

shaft (hereinafter simply called the steering shaft) through bearings 109, 111. A steering wheel (not shown) is attached to an upper end (the right end in Fig. 6) of the steering shaft 113, while a lower end (the left end in Fig. 6) of the steering shaft 113 is coupled to a rack and pinion mechanism of a steering mechanism through a universal joint, a lower steering shaft, and the like. Referring to Fig. 6, snap rings are provided on the right side of the bearing 109 and on the left side of the bearing 111, respectively.

The steering column 101 is formed of a steel pipe to be generally cylindrical by hydroforming, with a distance unit 121 being integrally formed to be expanded at positions corresponding to the upper brackets 103, 104 which are to be mounted on the car body, and with a lower expanded portion 141 is formed at a position corresponding to a vehicle body mounting lower bracket 105 which is to be fixed to the car body.

The upper brackets 103, 104 have the width along the length of the steering shaft, and are symmetrically extended in a direction perpendicular to the extending direction of the steering shaft, that is, the right-and-left direction in Fig. 7A, and integrally comprise a pair of vehicle body mounting portions 103a,104a which are secured to the vehicle body strength member by fixing members such as bolts

(not shown).

The body mounting portions 103a, 104a of the upper brackets 103, 104 are bent at right angles at inner sides respectively and extended backward (to the right in Fig. 6) and in the up-and-down direction to integrally form a pair of side plate portions 103c, 104c.

The distance unit 121 of the steering column 101 is integrally formed to be expanded upward in a higher position than the axial line of the steering shaft 113, and integrally comprises flat side walls 121a, 121b which are clamped by and between the side plate portions 103c, 104c of the upper brackets 103, 104 and a top portion 121c which connects these side wall portions 121a, 121b at the upper ends thereof.

The side plate portions 103c, 104c of the upper brackets 103, 104 are formed with elongated holes 115, 117 for tilt adjustment which will be described later. Also elongated holes 130 which are extended in a predetermined length in the axial direction for telescopic position adjustment of the steering column are formed on the side wall portions 121a, 121b of the distance unit 121. The distance unit 121 is clamped between the side plate portions 103c, 104c of the upper brackets 103, 104 with a predetermined clamping force by the use of a bolt 123 and a nut 125, the bolt 123 passing through the elongated holes 115,

117 for tilt adjustment of the side plate portions 121a, 121b and the elongated holes 130 of the side wall portions 121a, 121b. Between the head portion 123a of the bolt 123 and the side plate portion 103c on the bracket side, known cam elements 135, 137, a lever 139 for tilting and/or telescopic position adjustment and a thrust bearing 133 are interposed on the bolt 123 from the side of the side plate portion 103c.

The cam element 135 is unable to rotate since a projection 135a which is extended rightward in Fig. 7A is engaged with the elongated hole 115 of the bracket side plate 103c. The other cam element 137 is in an integral relationship with the lever 139 for tilting and/or telescopic position adjustment. When the lever 139 for tilting and/or telescopic position adjustment is manually rotated, the cam element 137 is rotated together with the lever 139. As a result, a relative position between the cam elements 135, 137 is changed in the axial direction of the bolt 123, so that a distance between the cam element 135 and the nut 125 is changed to change a distance between the side plate portions 103c and 104c, thereby clamping and fixing the side wall portions 121a, 121b of the distance unit 121 or releasing this clamped and fixed state.

The body-side lower bracket 105 which is secured

to the body-side strength member in a more front part of the vehicle than the upper brackets 103, 104 integrally comprises a lower body mounting member 105a which is fixed to the body-side strength member by bolts, or the like, and a column mounting member 105d which is provided with a pair of vertical plate portions 105b, 105c which are extended in parallel downward from the body mounting member 105a.

The lower expanded portion 141 formed in a lower part of the steering column 101 integrally comprises flat plate portions 141b, 141c which are extended in the up-and-down direction to be corresponding to the vertical plate portions 105b, 105c of the lower body mounting member 105a to be brought into pressure contact, respectively, and a top portion 141d for connecting these portions to each other. The vertical plate portions 105b, 105c and the flat plate portions 141b, 141c of the column-side lower expanded portion 141 are respectively formed with elongated holes 140 extended in the axial direction, and a bolt 143 is inserted through these elongated holes to effect clamping in cooperation with a nut 145.

In the present embodiment, in order to adjust a tilting position and/or a telescopic position of the steering column, the position adjusting lever is rotated, and the clamped state of the distance unit 121 by the side plate portions 103c, 104c of the

upper brackets 103, 104 is released, so that the driver can move the steering column in the axial direction, and/or change an inclination of the steering column. Upon completion of the desired adjustment, the position adjustment lever is rotated in the opposite direction to clamp the distance unit 121 again.

In the present embodiment, when an inclination of the steering column is adjusted to an upper limit position, it is preferable that the lower end of the body-side upper bracket is positioned higher than the lower end of the column.

In the present embodiment, though the elongated holes are formed on the lower expanded portion 141 to allow axial position adjustment of the column, there may be provided only circular holes of a size enough for passing the bolt 143, so that only a tilting position is adjustable.

In addition, the shapes of the upper brackets 103, 104 are not limited to those described above, but may be any form so long as it comprises body mounting portion and a column mounting portion.

The specific description of the embodiments of the present invention is as stated above. However, the present invention is not limited to the foregoing embodiments. For example, plastic working of the steering column may be performed by employing a

method other than hydroforming, such as explosive bulging, rubber bulging, or press-forming. A specific structure of the steering column apparatus, and a material, a shape, etc., of each constituent member may be properly changed within a scope and spirit of the present invention.

As described above, according to a steering column apparatus of the present invention, it is rendered possible to reduce an expanded amount of the distance unit from the steering column to the minimum by, for example, disposing an adjusting bolt immediately above the steering shaft, so as to make a layout of the steering column apparatus easy. In case of the steering column apparatus having a tilt adjusting mechanism, a range of movement of the adjusting bolt is positioned comparatively high with respect to the steering column, so that the lower end of the body-side bracket is difficult to be protruded from the lower surface of the steering column. As a result, there is less risk that a knee of the driver will come in contact with the body-side bracket at the time of collision or the like of the vehicle.